Characterization of full-scale sludge viscosity and density: Testing the stratification hypothesis

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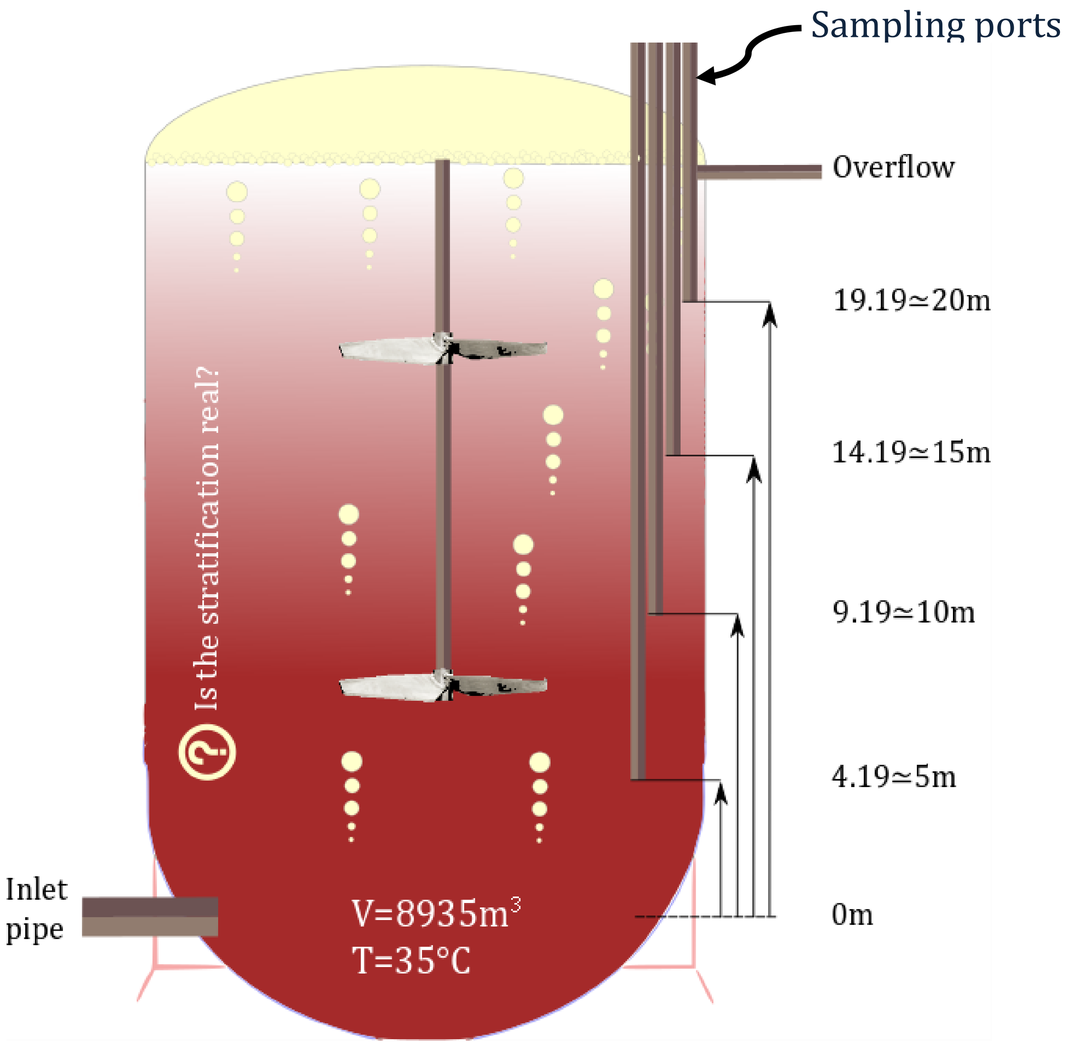
Motivation of work

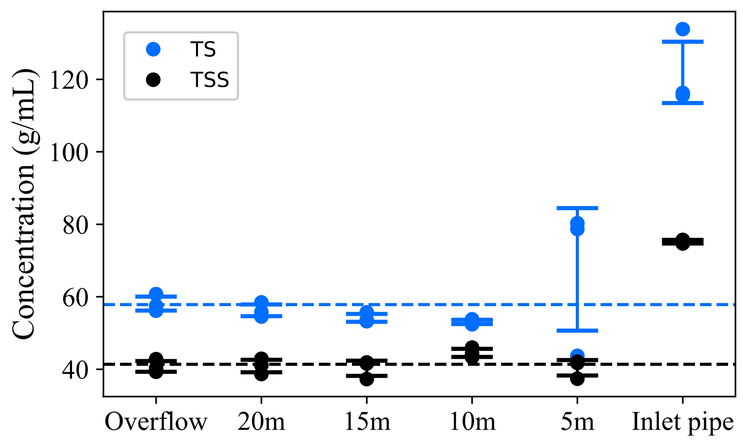
- **Objective:** Test the stratification hypothesis in a WWTP full-scale anaerobic digester (Breda, The Netherlands).
- **Why?** It has been often mentioned in literature, but little or no evidence at all has been provided so far to prove its existence.
- **How?** By characterizing the sludge properties at different heights
- **Benefits?** Mixing is evaluated in terms of height heterogeneities
  Better understanding of its spatial behaviour
  Knowledge can be used to reduce model uncertainties

Full-scale WWTP reactor



Concentration

- **Method:** Standard methods (2540B, 2540D) with triplicates



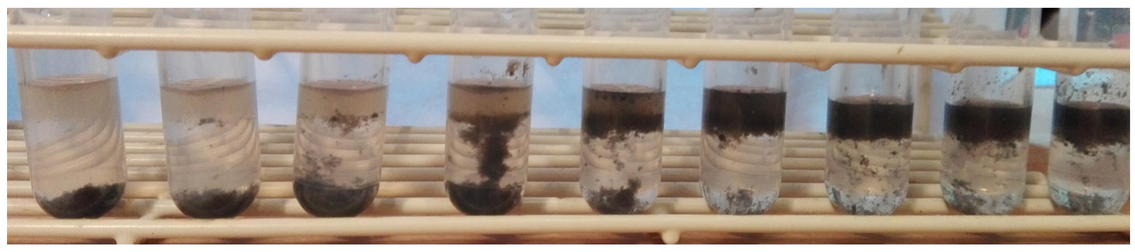
- Stratification is present in terms of TS below 10m depth.

Bulk & Floc densities

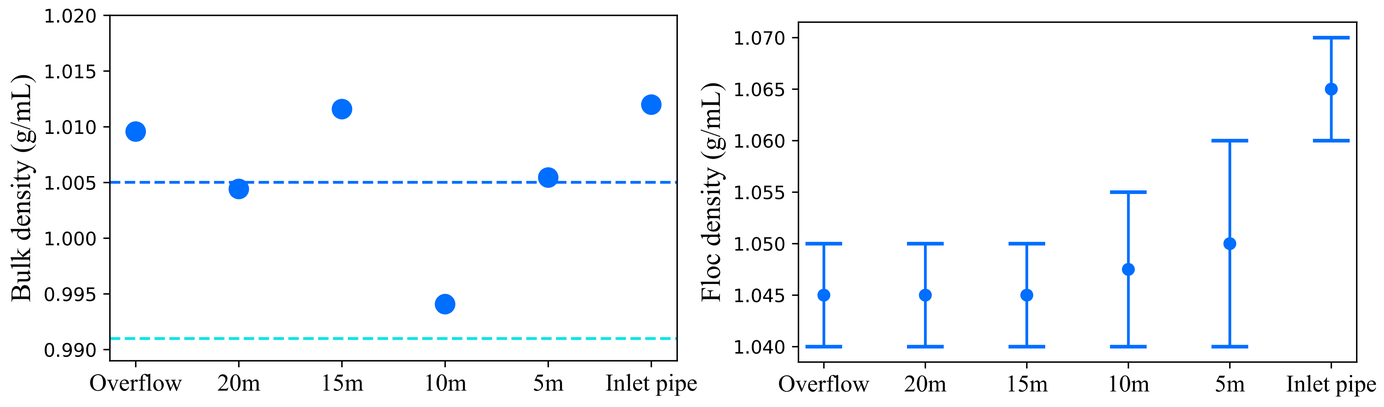
- **Bulk ρ method:** Calibrated pycnometer (50 mL)
- **Method:** Percoll™ PLUS (ρ=1.13 g/mL)
  Effluent water (ρ≈0.99 g/mL)

Results from overflow sludge with Δρ=0.005 g/mL

1.03 1.035 1.04 1.045 1.05 1.055 1.06 1.065 1.07



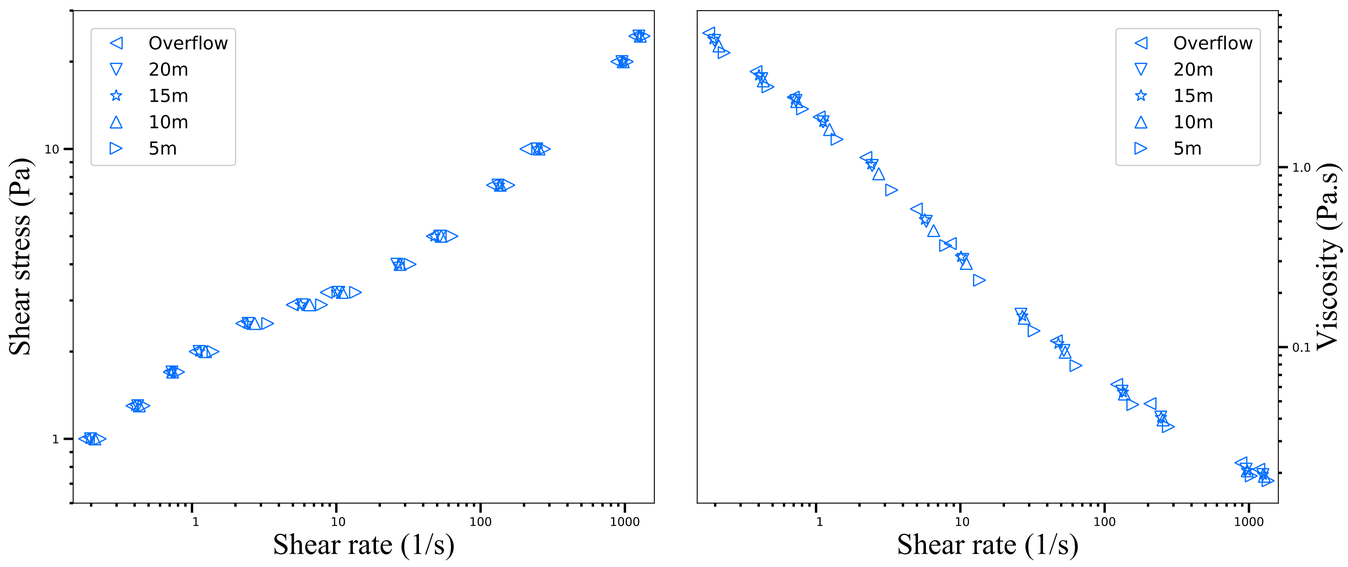
Bars should be interpreted as observed density ranges



- Little difference is found with respect to water bulk density.
- Mild differences are found on floc density below 15 m depth.

Rheology

- **Method:** Anton Paar MCR305 rheometer at T=35°C
  Shear stress controlled mode: pre-shear > rest > shear



- There is currently no criterion to determine if stratification is present.

Conclusions

- From a physical characterization, a mild stratification may be present below 10 m depth (≈ 46.5% of the reactor volume).
- Results do not fully imply that the reactor is CSTR.
- A single-phase non-Newtonian can be justified to be a valid modeling assumption in a Computational Fluid Dynamic model

Contact

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